Component of Statistics Canada Catalogue no. 82-003-X
Health Reports

Article

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December, 2009

Statistics Canada Statistique Canada

Canada

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Abstract

Background
Area-based indicators are commonly used to measure and track health outcomes by socio-economic group. This is largely because of the absence of socio-economic information about individuals in health administrative databases. The literature shows that the magnitude of differences in health outcomes varies depending on whether the socio-economic indicators are at the individual level or are area-based. This study compares the two types of indicators.

Data and methods
The data are from a file linking the results of the 1991 Census with deaths that occurred from 1991 to 2000—a 15% sample of the Canadian population aged 25 or older. The socio-economic indicator used for comparison is a material and social deprivation index, in individual and area-based versions. The health indicators are life expectancy and disability-free life expectancy, and risks of mortality and disability.

Results
The individual version of the deprivation index yields wider gaps in life expectancy and disability-free life expectancy than does the area-based version. These gaps vary by sex and geographic setting. However, both versions are associated with inequalities in mortality and disability, independent of each other.

Interpretation
Despite some limitations, area-based socio-economic indicators are useful in assessing inequalities in health. The inequalities that they identify are significant, consistent and reliable and can be tracked through time and for different geographic settings.

Keywords
area-based measure, deprivation, disability-free life expectancy, geography, life expectancy, social inequalities

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Indicators of health status and the health care system in Canada are available in publications such as the *Federal Report on Comparable Health Indicators* (2002, 2004 and 2006)[1] and the annual online series, *Health Indicators*, which has been produced since 2002.[2] These sources provide more than one hundred indicators, by sex, age group, province and health region, but only one indicator, health-adjusted life expectancy, is connected to a socio-economic measure—average neighbourhood income.[1] Therefore, it is not surprising that participants in a recent conference[3] recommended that health indicators take the concept of equity into account, specifically, that they incorporate socio-economic status and place of residence (urban or rural).

Data from national surveys such as the Canadian Community Health Survey can be used for this purpose.[4] Administrative databases, such as those for deaths or hospitalizations—essential for describing the health status of the population or the use of health care services—can also be used. But because administrative databases contain no socio-economic information about the persons concerned, it is necessary to introduce area-based indicators in such databases for monitoring social inequalities in health.

However, the magnitude of the health inequalities that are identified can vary depending on whether the socio-economic data pertain to individuals or are area-based. Some earlier studies have reported that relationships between health indicators and socio-economic conditions are stronger when those conditions are measured at the individual level.[5-10] Other studies have found that the

magnitude of health inequalities based on individual and area-based data is similar, for the entire population,[11] or a portion of it.[12,13] These divergent findings do not appear to be attributable to the size of the geographic unit, but rather to the heath indicator itself and to the nature and formulation of the socio-economic indicators that are used. However, all the authors agree that individual and area-based socio-economic indicators do not reflect the same reality; that they are based on different constructs; and that they contribute independently to the health gaps observed.[5,11-13]

In Canada, just one study has examined this issue,[14] estimating, for a representative sample of Manitobans, the contribution of household income and average neighbourhood income (enumeration area) to mortality, disability, nursing home admissions, morbidity related to care and hospitalization, mental health problems, and fertility from 1986 to 1989. On all these outcomes, except disability and the prevalence of mental health problems, the variations associated with each income decile were comparable at the individual and area-based levels. For disability and mental health problems, variations by household income were larger than by neighbourhood income. As well, the study identified comparable gaps between urban and rural environments for all health outcomes, except disability and mental health problems. For disability, the contribution of income was greater in urban environments for both the individual and area-based measures.

These findings demonstrate that if area-based indicators are used to monitor health status, it is necessary to recognize that they reflect not only the characteristics of the population, but also those of the physical and social setting. Therefore, the study of area-based indicators is important—to estimate their contribution to health and to determine how they vary by geographic setting. An American team, in fact, has undertaken such research.[15]

The recent availability of a file linking 1991 Census of Canada data to deaths that occurred from 1991 to 2001 offers an opportunity to compare the respective contributions of individual and area-based data to health indicators derived from administrative databases.[10] The present study examines how the individual and area-based versions of a deprivation index contribute to estimates of life expectancy and disability-free life expectancy.[16] The objectives are first to compare the size of the life expectancy and disability-free life expectancy gaps between the individual and area-based versions of the index, and then to determine if each version contributes independently to those gaps.

Data and methods

The data are from a linkage between 1991 Census of Canada data and records of deaths that occurred from June 4, 1991 to December 31, 2001.[10] The data constitute a 15% sample of the non-institutionalized population aged 25 or older. This study concerns 99% of that population (n = 2,708,300), that is, people to whom it was possible to assign a deprivation index.

Geographic breakdown

The study pertains to the Canadian population as a whole and to four geographic settings based on the Statistical Area Classification developed by Statistics Canada[17] that reflect the urban-rural continuum: (1) the largest CMAs (census metropolitan areas)—Toronto, Montreal and Vancouver; (2) other CMAs (population more than 100,000); (3) census agglomerations (population 10,000 to 100,000); and (4) metropolitan influenced zones, hereafter called "small towns and rural" (municipalities with a population less than 10,000).

Deprivation index

The deprivation index is a Canada-level version of an area-based index developed for Quebec,[18-20] using 1991 enumeration areas (contiguous residential blocks, each containing an average of about 700 residents).[21] The deprivation index, derived from the proposals of Peter Townsend,[22] embodies two forms of deprivation: material and social. Material deprivation refers to the lack of the goods and conveniences that are part of modern life; social deprivation refers to the fragility of the social network, from the family to the community. The deprivation index in this analysis combines six socio-economic indicators:[23-28] no high school diploma; employment; income; being widowed, separated or divorced; living alone; and being in a lone-parent family.

For the area-based version of the index, these indicators are expressed as a percentage or average (for income) by enumeration area. These indicators are grouped under the two dimensions of deprivation (material and social), obtained from principal component analysis. The material dimension reflects education, employment, and income; the social dimension reflects marital status and the structure of the household or family. On both dimensions of deprivation, enumeration areas were divided into population quintiles (20% groups), from the most advantaged (quintile 1) to the least advantaged (quintile 5) based on a factor score. This was done for Canada as a whole and for each geographic setting, based on the principal component analysis (and factor scores) carried out in each setting.

The individual version of the index uses the six socio-economic indicators selected for the enumeration area version in either binary form (for example, having or not having a job) or continuous form (income). The income measure differs slightly—personal income is used for people living alone or in non-family households; for other people, family income adjusted for family size is used. The six indicators were grouped under the material and social dimensions of deprivation, using the standardized scoring coefficients drawn from the various principal component analyses. Individuals were then distributed into population quintiles from the most advantaged (quintile 1) to the least advantaged (quintile 5) on each of the two dimensions according to the factor

score. This was done for Canada as a whole and for each geographic setting.

For the social dimension of deprivation, it was not possible to distribute individuals among quintiles. With the indicators comprising this dimension—marital status (widowed, separated or divorced), living alone, and living in a lone-parent family—it was possible to distinguish only two groups: (1) people who tended to have none of these characteristics (about 80% of the population); and (2) people who tended to have at least one of these characteristics (about 20% of the population). Consequently, the comparison between the individual and enumeration area versions of the social dimension of deprivation pertains to these two groups, one consisting of quintiles 1, 2, 3 and 4 (most advantaged), and the other consisting of quintile 5 (least advantaged). More details on the construction of the index are provided in the Appendix.

Health indicators

Two health indicators[10] are considered here: mortality and disability.[21] It was possible to assign a deprivation index to 98% of those who had died (n = 255,780) or who reported a disability (n = 352,400) in the 1991 Census.

Life expectancy and disability-free life expectancy at age 25 were calculated. Disability-free life expectancy[16] is the number of years someone aged 25 (between 1991 and 2001) could expect to live without activity limitations or disability. The life expectancy and disability-free life expectancy calculations are based on the methods of Chiang[29] and Sullivan,[30] respectively, adapted for survival.[10] Confidence intervals of 95% were calculated for both indicators.[29,31]

To verify whether the individual and enumeration area-based versions of the deprivation index both contribute to the health gaps between quintiles and whether they do so independently, two measures included in the calculation of disability-free life expectancy were used: the proportional hazards ratio for mortality from 1991 to 2001 and the relative risk of disability in 1991. They were modelled using Cox regression[32] (mortality) and negative binomial regression[33] (disability). Separate models were produced for the material and social dimensions of deprivation, and the mortality and disability risks were adjusted for age, sex, geographic setting and the other dimension of deprivation. A first model estimated the contribution of the individual version of the deprivation index alone, and then with the area-based version of the index. A second model estimated the contribution of the area-based version of the deprivation index alone, and then with the individual version of the index. Mortality and disability risks were calculated for the extreme quintiles of material deprivation (quintile 1 versus quintile 5) and social deprivation (quintiles 1, 2, 3, 4 versus quintile 5). They may be interpreted as follows: a value of 2.00 means that the risk of mortality or disability of the least advantaged group is two times greater than that of the most advantaged group. The calculations were made using the SAS procedures PHREG and GENMOD.

Finally, the possibility that the absence of a deprivation index for 1% of the population and 2% of deceased persons or persons with disabilities could bias the estimates of life expectancy and disability-free life expectancy was checked. To do this, everyone for whom a deprivation index could not be calculated was considered to belong to the least advantaged group (quintile 5), and new estimates of life expectancy and disability-free life expectancy were produced. These proved to be similar to those already obtained.

Results

Life expectancy

The individual and enumeration area versions of the deprivation index show gaps in life expectancy at age 25 that vary in magnitude (Figure 1). On the *material* dimension, the calculations using data for individuals yield life expectancy estimates that range from 61.2 years for the most advantaged (quintile 1) to 52.4 years for the least advantaged (quintile 5)—a difference of 8.8 years (CI: 8.0; 9.6). The corresponding values using enumeration area data are 57.5 years and 54 years—a difference of 3.5 years (CI: 3.7; 4.2).

On the *social* dimension of deprivation, the difference in life expectancy between the most advantaged group (quintiles 1, 2, 3 and 4) and the least advantaged group (quintile 5) is 3.9 years (CI: 3.7; 4.2) using data for individuals, and 2 years (CI: 1.8; 2.0) using data for enumeration areas.

Disability-free life expectancy

For disability-free life expectancy, the gaps persist (Figure 2). On the *material* dimension of deprivation, the difference in disability-free life expectancy at age 25 between the most advantaged group and the least advantaged group is 14 years (CI: 13.2; 14.8), using data for individuals. With enumeration area data, the gap is 5.1 years (CI: 4.9; 5.3).

On the *social* dimension of deprivation, the difference in disability-free life expectancy between the most advantaged group and the least advantaged group is 5.3 years (CI: 5.1; 5.5) using data for individuals, and 2.8 years (CI: 2.6; 3.0) with data for enumeration areas.

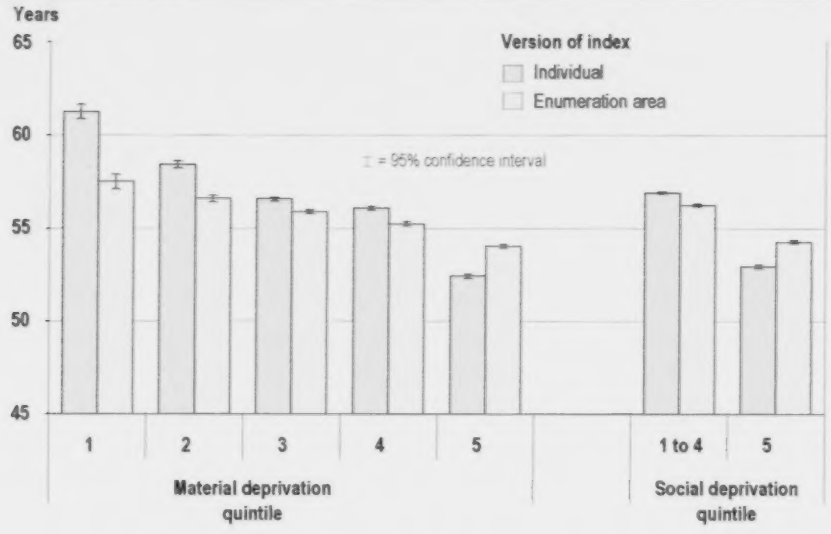
Differences between men and women

Disadvantage-based inequalities in life expectancy and disability-free life expectancy at age 25 are greater among men than among women, regardless of whether individual or enumeration area data are used (Table 1). However, for life expectancy, differences in magnitude are greater among women than among men. For example, on the material dimension of deprivation, the gap in women's life expectancy is 8.1 years using individual data and 2.8 years using enumeration area data; among men, the gaps are 9.5 years and 4.2 years, respectively.

Geographic setting

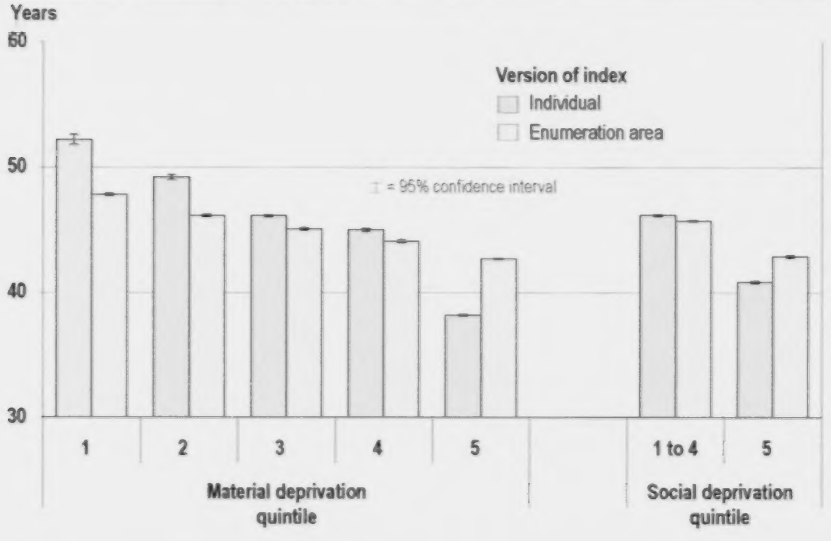
Disadvantage-based inequalities in life expectancy and disability-free life

Figure 1
Life expectancy at age 25 according to individual and enumeration area versions of deprivation index, by material and social deprivation quintile, Canada, 1991 to 2001



Source: Census mortality follow-up study, 1991 to 2001

Figure 2
Disability-free life expectancy at age 25 according to individual and enumeration area versions of deprivation index, by material and social deprivation quintile, Canada, 1991 to 2001



Source: Census mortality follow-up study, 1991 to 2001.

expectancy emerge for all geographic settings, regardless of the version of the deprivation index. However, the size of inequalities related to material deprivation varies according to the version used. With individual data, gaps in life expectancy are greater in CAs (8.6 years) and in small towns and rural areas (7.4 years) than in the largest CMAs (5.4 years) and other CMAs (6.4 years) (Figure 3). But with enumeration area data, only the other CMAs have a wider life expectancy gap (4 years) than do the other community size categories.

For disability-free life expectancy, the use of data for individuals to assess material deprivation yields greater differences between quintiles in CAs (13.7 years) than elsewhere (Figure 4). But with data for enumeration areas, the differences between quintiles in disability-free life expectancy in small towns and rural areas (11.4 years) exceed those in the largest CMAs (10.2 years). Conversely, the data for enumeration areas show greater differences between quintiles in the other CMAs (6.7 years) than elsewhere, and narrower gaps in small towns and rural areas (3.1 years) than in the largest CMAs (4.5 years).

Independent associations

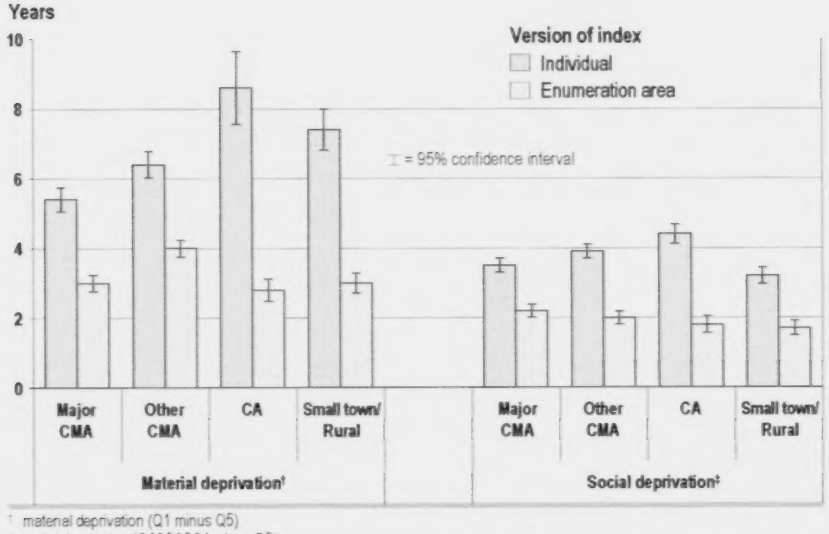
Nonetheless, both versions of the index contribute significantly to the life expectancy and disability-free life expectancy gaps observed. The proportional mortality risk in the 1991-to-2001 period and the relative risk of disability in 1991 between the most and least advantaged groups are independently associated with both material and social deprivation (Table 2). With regard to material deprivation, the contribution of the individual version substantially exceeds that of the enumeration area version. For example, the relative risk of disability for the least advantaged versus the most advantaged group is 211% greater when the calculation is made with individual data, but 6% greater when enumeration area data are used.

Table 1
Life expectancy and disability-free life expectancy at age 25 highest and lowest quintiles of material and social deprivation, by sex and individual and enumeration area versions of index, Canada, 1991 to 2001

	Life expectancy						Disability-free life expectancy					
	Men			Women			Men			Women		
		95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval	
Deprivation *Version of index*	Years	from	to	Years	from	to	Years	from	to	Years	from	to
Total	**52.6**	**52.6**	**52.7**	**59.0**	**59.0**	**59.1**	**43.3**	**43.3**	**43.4**	**46.9**	**46.9**	**47.0**
Material deprivation												
Individual												
Quintile 1	57.7	57.4	58.1	64.8	64.1	65.5	50.7	50.3	51.0	53.7	52.9	54.4
Quintile 5	48.2	48.0	48.3	56.7	56.6	56.8	34.3	34.1	34.5	42.0	41.9	42.2
Quintile 1 minus quintile 5	9.5	9.2	9.9	8.1	7.4	8.9	16.3	16.0	16.7	11.7	10.9	12.4
Enumeration area												
Quintile 1	54.8	54.6	54.9	60.3	60.1	60.4	46.5	46.4	46.7	49.0	48.9	49.2
Quintile 5	50.6	50.5	50.7	57.5	57.4	57.6	40.5	40.4	40.7	44.8	44.7	44.9
Quintile 1 minus quintile 5	4.2	4.0	4.4	2.8	2.6	2.9	6.0	5.9	6.1	4.2	4.1	4.4
Social deprivation												
Individual												
Quintiles 1 to 4	53.3	53.3	53.4	60.4	60.3	60.5	44.3	44.2	44.3	48.0	47.9	48.1
Quintile 5	48.7	48.5	48.8	57.2	57.1	57.3	37.8	37.7	38.0	43.8	43.7	43.9
Quintiles 1 to 4 minus quintile 5	4.7	4.5	4.8	3.2	3.1	3.3	6.4	6.4	6.5	4.2	4.1	4.3
Enumeration area												
Quintiles 1 to 4	53.2	53.1	53.2	59.3	59.2	59.4	43.9	43.9	44.0	47.4	47.3	47.5
Quintile 5	50.5	50.3	50.6	58.1	57.9	58.2	40.5	40.4	40.7	45.1	45.0	45.2
Quintiles 1 to 4 minus quintile 5	2.7	2.6	2.8	1.2	1.2	1.3	3.4	3.3	3.5	2.3	2.2	2.3

Source: Census mortality follow-up study, 1991 to 2001.

Figure 3
Difference in life expectancy at age 25 between highest and lowest quintiles (Q) of material[†] and social[‡] deprivation, by version of index and geographic setting, Canada, 1991 to 2001



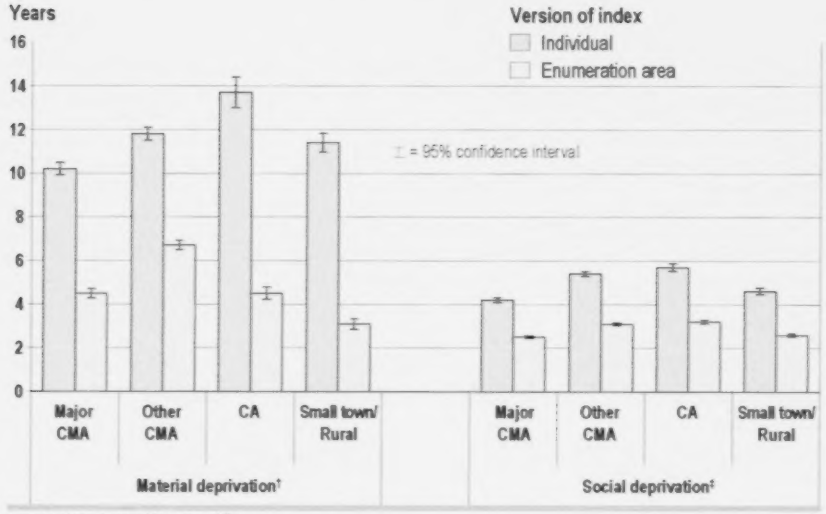
† material deprivation (Q1 minus Q5)
‡ social deprivation (Q4Q3Q2Q1 minus Q5)
Note: Major CMA (census metropolitan area): Toronto, Montreal and Vancouver; other CMA: population 100,000 or more; CA (census agglomeration): population 10,000 or more; small town/rural: population less than 10,000
Source: Census mortality follow-up study, 1991 to 2001.

With regard to social deprivation, the two versions of the index yield closer estimates.

Discussion

The individual and enumeration area versions of the deprivation index reveal major disparities in life expectancy and disability-free life expectancy at age 25 for the material and social forms of disadvantage. The direction of these disparities is the same for the two versions of the index: an increase in disadvantage is accompanied by a reduction in life expectancy, with or without disability. However, the size of the disparities varies. Life expectancy and disability-free life expectancy gaps between the groups at the ends of the advantaged-disadvantaged continuum are much greater when measured at the individual level. This applies to the Canadian population as a whole, to men and women, and to each geographic setting.

Figure 4
Difference in disability-free life expectancy at age 25, between highest and lowest quintiles (Q) of material[1] and social[2] deprivation, by version of index and geographic setting, Canada, 1991 to 2001



† material deprivation (Q1 minus Q5)
‡ social deprivation (Q4Q3Q2Q1 minus Q5)
Note: Major CMA (census metropolitan area): Toronto, Montreal and Vancouver; other CMA: population 100,000 or more; CA (census agglomeration): population 10,000 or more; small town/rural: population less than 10,000.
Source: Census mortality follow-up study, 1991 to 2001.

Table 2
Contribution of individual and enumeration area versions of material and social deprivation index to proportional risk of mortality (1991 to 2001) and relative risk of disability (1991), Canada

	Mortality (1991 to 2001)			Disability (1991)		
		95% confidence interval			95% confidence interval	
Deprivation	Proportional risk[1]	from	to	Relative risk[2]	from	to
Material deprivation						
Individual version of index [model 1]						
alone	2.03	1.99	2.07	3.17	3.09	3.26
and enumeration area version	1.96	1.92	1.99	3.11	3.03	3.20
Enumeration area version of index [model 2]						
alone	1.36	1.34	1.38	1.15	1.09	1.20
and individual version	1.12	1.10	1.13	1.06	1.04	1.09
Social deprivation						
Individual version of index [model 1]						
alone	1.39	1.38	1.41	1.51	1.49	1.53
and enumeration area version	1.37	1.35	1.38	1.50	1.48	1.53
Enumeration area version of index [model 2]						
alone	1.21	1.20	1.22	1.14	1.10	1.17
and individual version	1.15	1.14	1.16	1.12	1.10	1.13

[1] proportional risk between quintile 5 and quintile 1 (material deprivation) and between quintile 5 and quintiles 1 to 4 (social deprivation), adjusted for age, sex, geographic setting and other form of deprivation
[2] relative risk between quintile 5 and quintile 1 (material deprivation) and between quintile 5 and quintiles 1 to 4 (social deprivation), adjusted for age, sex, geographic setting and other form of deprivation
Source: Census mortality follow-up study, 1991 to 2001.

Consistent with the literature, these results suggest that associations between health and socio-economic characteristics are stronger when the latter are measured at the individual rather than the area level.[5-9] An examination of each of the six indicators that make up the deprivation index shows that the individual version is more effective at identifying vulnerable or advantaged populations (Table 3). Also, the results corroborate the findings of the Manitoba study[14] with regard to disability, and those of the national study[10] with regard to life expectancy at age 25.

The results of the present study show greater divergences between individual and enumeration area measures among women than among men. Thus, it appears that enumeration area indicators underestimate disadvantage-based life expectancy differences to a greater extent among women than among men. The national study,[10] which used the same file, also revealed larger divergences for women between the individual and enumeration area measures. As well, a study[5] conducted in the Renfrew district in Scotland reported a steady increase in mortality among men with both the level of deprivation in the postal code zone and manual labourer status; for women, only manual labourer status influenced mortality.

According to the results of this analysis, the largest discrepancies between individual and area-based measures are by geographic setting. It appears that the enumeration area version of the deprivation index underestimates life expectancy and disability-free life expectancy gaps between quintiles in CAs and in small towns and rural areas. No similar finding was reported in the international literature or in the Manitoba study. However, comparisons of social inequalities between urban and rural environments are not exempt from statistical artifacts, especially those related to differences in the small geographic units included in the analysis. For example, the range of social disparities between these units is greater in urban than in rural areas, whereas the

Table 3
Socio-economic characteristics of population, by material and social deprivation quintile and area-based and individual versions of deprivation index, Canada, 1991

	No high school diploma		Employment/ Population		Average income		Separated, divorced, widowed		Living alone		Lone-parent families	
	Area	Individual	Area	Individual	Area	Individual	Area	Individual	Area	Individual	Area	Individual
	%		ratio		$		%		%		%	
Total	**37.4**	**37.4**	**65.5**	**65.5**	**26,389**	**26,389**	**13.3**	**13.3**	**11.2**	**11.2**	**6.3**	**6.3**
Material deprivation												
Quintile 1	19.4	0.0	73.0	100.0	37,493	47,341	11.8	12.5	12.3	17.7	4.6	4.6
Quintile 2	29.7	0.6	70.5	97.6	28,308	29,789	12.1	7.5	10.2	4.6	5.4	6.2
Quintile 3	37.1	19.9	67.7	59.1	25,102	23,746	13.0	13.9	10.4	12.7	6.0	5.3
Quintile 4	44.8	66.8	63.3	64.0	22,310	18,683	14.2	8.1	11.3	4.2	6.8	7.3
Quintile 5	56.9	100.0	52.6	6.4	18,105	12,244	15.4	24.2	11.9	16.9	8.8	8.3
Social deprivation												
Quintiles 1, 2, 3, 4	37.1	35.1	67.1	69.5	27,097	27,214	10.9	0.0	7.9	0.0	5.6	0.0
Quintile 5	38.5	46.4	58.8	49.6	23,564	23,091	22.7	66.2	24.7	56.1	9.2	31.5

Note: See Appendix for statistical definition of characteristics.
Source : Census mortality follow-up study, 1991 to 2001.

What is already known on this subject?

- In Canada, social inequalities in health are monitored mainly with the use of area-based socio-economic indicators.
- The size of these inequalities can vary depending on whether the socio-economic indicator is area-based or at the individual level.

What does this study add?

- This study uses a Canadian index of material and social deprivation as a socio-economic indicator to examine differences in Canada as a whole and in selected geographic settings.
- Inequalities in life expectancy, with or without disability, are greater when measured at the individual level, especially in certain geographic settings.
- Both the individual and the area-based versions of the deprivation index are associated with inequalities in mortality and disability.
- Despite their limitations, area-based indicators continue to be appropriate measures for monitoring social inequalities in health.

size and social homogeneity of these units is less in rural areas.[34,35] Also, in Canada, correspondence between postal codes (in death certificates) and enumeration areas (for identifying socio-economic data) is more imprecise in CAs, small towns and rural areas than in CMAs.[36] While this lack of precision did not affect the results of the current study (the file provided optimal correspondence[10]), this issue could arise in routine mortality tracking.

As other researchers have found,[5,11-13] the results show that both the individual and area versions of the deprivation index are associated with differences in mortality and disability in Canada. These two versions reflect different realities that can be related to the compositional and contextual factors to which reference is made in interpreting local inequalities in health.[37,38] As well, it appears that the material and social forms of deprivation simultaneously affect the differences observed. Enumeration area measures often cover only the material dimension (for example, income) of deprivation, while social factors, such as social isolation, are also powerful determinants of health.[39,40]

Limitations

This study has limitations. It presents a deprivation index based on six socio-economic indicators that could have been designed and combined differently, on both the individual and area-based levels.

This analysis attempted to reflect the multiplicity of social determinants of health and to maximize the comparability of the two scales. Other determinants, such as immigrant or Aboriginal status, could have been used, and their influence on the results for the major CMAs, CAs, and small towns and rural areas might have been different.[41,42] Nonetheless, such characteristics could be added to the deprivation index in modelling social inequalities in health.

Finally, this study is limited to two health indicators—life expectancy and disability-free life expectancy; studies examining other measures might yield different results. Even so, these two indicators are broad measures of health status, and they are in the forefront of health status monitoring in Canada.[2-4]

Conclusion

This study suggests that area-based socio-economic indicators detect only a portion of social inequalities in health, a portion that varies by gender and geographic setting. Ultimately, these indicators are only markers of inequalities. For such inequalities to be better understood, etiological studies that incorporate the various health determinants in both their individual and their area-based forms are

necessary. But as long as administrative databases lack individual socio-economic information, the use of area-based indicators for monitoring social inequalities in health will be unavoidable.

Several advantages of area-based indicators emerge from this study:[43] they cover a broad socio-economic spectrum (in both material and social terms); they characterize the entire population (males and females, from various geographic settings); they produce estimates that are statistically reliable and consistent with individual indicators (the direction of the relationships is identical); and they detect sizable inequalities between groups. Lastly, with area-based indicators, such inequalities can be tracked through time and by geographic location. For these reasons, and despite their limitations, area-based indicators continue to be appropriate tools for monitoring social inequalities in health. ■

Acknowledgement

We thank Russell Wilkins of Statistics Canada for facilitating our access to and use of the database matching the census and mortality data.

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Appendix

Table A
Socio-economic characteristics

	Area-based†			Individual		
Characteristic	**Label**	**Description**	**Possible values**	**Label**	**Description**	**Possible values**
Income	INCOME	Average total personal income for persons aged 15 or older and reporting income	Transformed and normalized. Values = -3.57 to 15.68	INCIND	For unattached individual, total personal income; otherwise, family income adjusted for family size	Normalized between -1 and +1‡ Values < -1 to -1 Values > 1 to 1
Education	EDUC	Percentage aged 15 or older without high school diploma	Transformed and normalized. Values = -3.58 to 3.67	EDUCIND	High school diploma	Absence = 1 Presence = -1
Employment	EMPL	Ratio of employment to population aged 15 or older	Transformed and normalized. Values = -3.43 to 2.54	EMPLIND	Person is working	Working = 1 Not working = -1
Separated/Divorced/ Widowed	S_D_W	Percentage aged 15 or older separated/divorced/ widowed	Transformed and normalized. Values = -2.30 to 8.85	S_D_WIND	Separated, divorced or widowed	Separated/Divorced/ Widowed = 1 Other = -1
Unattached individuals	UNATT	Percentage aged 15 or older living alone	Transformed and normalized. Values = -2.89 to 2.93	UNATTIND	Living alone	Living alone = 1 Not living alone = -1
Lone-parent families	LONE	Percentage of families that are lone-parent families	Transformed and normalized. Values = -3.39 to 2.87	LONEIND	Living in lone-parent family	Lone-parent family =1 Other = -1

† income, education, employment, separated/divorced/widowed and unattached individual adjusted to account for age and sex distribution in each enumeration area

‡ if income follows normal distribution, nearly 70% of normalized income values will be between -1 and 1; since other individual indicators are dichotomous, normalized income values must be brought back between -1 and 1 to prevent this variable from assuming too much importance

In both the individual and enumeration area versions of the deprivation index, the socio-economic characteristics were combined using factor weights (standardized scoring coefficients) obtained from area-based principal component analyses. These weights are shown in Table B. At the national level, the material and social deprivation factor scores for each enumeration area and each participant in the cohort result from the following equations:

Enumeration area version of index:

Material deprivation: (0.0903 X S_D_W) + (-0.0162 X LONE) + (0.1009 X UNATT) + (-0.3609 X EMPL) + (0.4690 X EDUC) + (-0.4046 X INCOME)

Social deprivation: (0.4415 X S_D_W) + (0.3463 X LONE) + (0.4130 X UNATT) + (-0.0294 X EMPL) + (0.1380 X EDUC) + (-0.0203 X INCOME)

Individual version of index:

Material deprivation: (0.0903 X S_D_WIND) + (-0.0162 X LONEIND) + (0.1009 X UNATTIND) + (-0.3609 X EMPLIND) + (0.4690 X EDUCIND) + (-0.4046 X INCIND)

Social deprivation: (0.4415 X S_D_WIND) + (0.3463 X LONEIND) + (0.4130 X UNATTIND) + (-0.0294 X EMPLIND) + (0.1380 X EDUCIND) + (-0.0203 X INCIND).

Table B
Factor weights of socio-economic characteristics, by community size, Canada, 1991

	Canada		Largest census metropolitan areas (CMA)		Other census metropolitan areas (CMA)		Census agglomerations (CA)		Small towns and rural	
Characteristic	Material deprivation	Social deprivation	Material deprivation	Social deprivation	Material deprivation	Social deprivation	Material deprivation	Social deprivation	Material deprivation	Social deprivation
Separated/divorced/widowed	0.0903	0.4415	0.0880	0.4410	0.1066	0.4424	0.1137	0.4316	0.0462	0.4532
Lone-parent families	-0.0162	0.3463	-0.0909	0.2734	-0.0478	0.2887	0.0126	0.3365	-0.1005	0.3692
Unattached individuals	0.1009	0.4130	0.1795	0.4834	0.2131	0.4938	0.1640	0.4396	0.0920	0.4091
Employment	-0.3609	-0.0294	-0.3205	-0.0140	-0.3774	-0.0906	-0.4583	-0.1592	-0.3660	0.0299
Education	0.4690	0.1380	0.4728	0.2093	0.5032	0.2118	0.4541	0.1218	0.4058	0.0533
Income	-0.4046	-0.0203	-0.3865	-0.0223	-0.3693	-0.0048	-0.3775	-0.0027	-0.4100	-0.0426

Note: Largest CMAs (census metropolitan areas): Toronto, Montreal and Vancouver; other CMAs: population 100,000 or more; CAs (census agglomerations): population 10,000 or more; small towns and rural: population less than 10,000.